

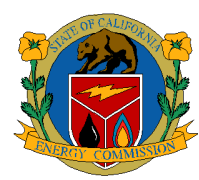
Climate Change Research at the Regional Level: California

Guido Franco

Public Interest Energy Research (PIER) Program
California Energy Commission

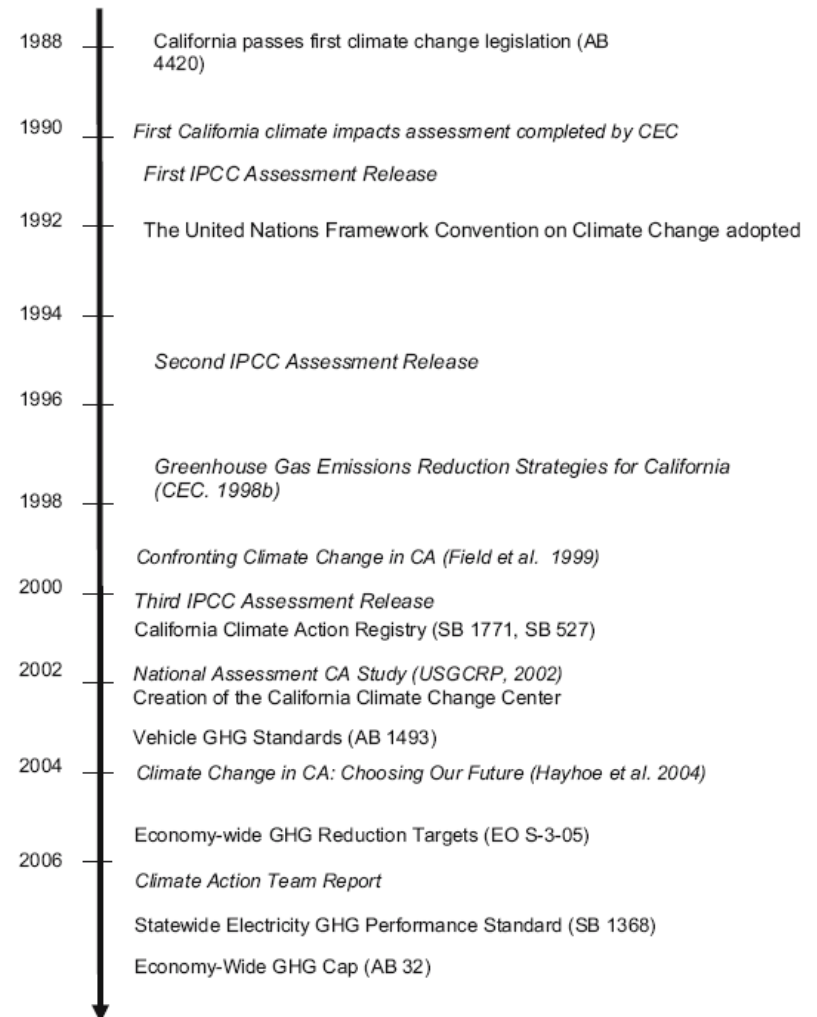
HMT-West 2010 Annual Meeting
October 7, 2010
Sonoma County Water Agency

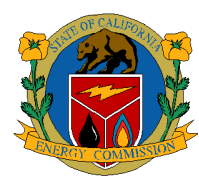




Climate Change Science Informing Policy in CA

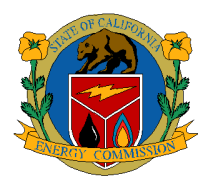
- The Energy Commission led the preparation of the first CA Assessment in 1990 (AB 4420)
- Studies at the national and international levels have been extremely useful
- Statewide GHG Inventory (1997)





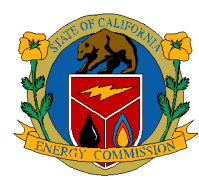
Climate Change Research at the Energy Commission

- PIER was created in the late 1990s (~\$80 million/yr) and started working on climate change in earnest in 2001
- First PIER Assessment released in 2003
- PIER long-term climate change research plan released in 2003
- PIER created the California Climate Change Center in 2003
 - First state-sponsored CC research initiative in the USA
 - Designed to complement national/international programs
 - Annual budget ~ \$6 million
 - Areas of research: 1) climate monitoring, analysis, and modeling; 2) GHG inventory methods; 3) Options to reduce net GHG emissions; and 4) impacts and adaptation studies



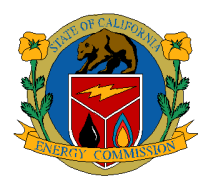
Climate Change Research at the Energy Commission (cont.)

- **Co-Directors:**
 - Dan Cayan – Scripps Institution of Oceanography/UC San Diego
 - Michael Hanemann – UC Berkeley
 - Guido Franco – PIER/Energy Commission
- More than 200 scientific PIER reports produced so far, most of them also published in the peer-reviewed literature



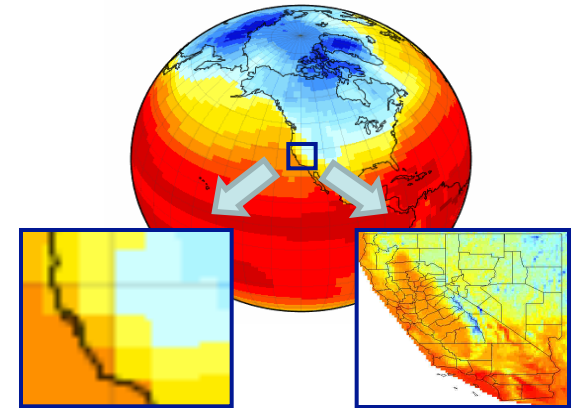
Approach

- Complement national and international effort to produce California-specific, policy relevant science (actionable science)
- Identify policy-driving questions
 - Example: How is climate changing in California? What are the factors responsible for these changes? How climate may evolve in CA in the 21st century?
- Develop a **long-term** research strategy to “answer” these policy questions within the budget constraints

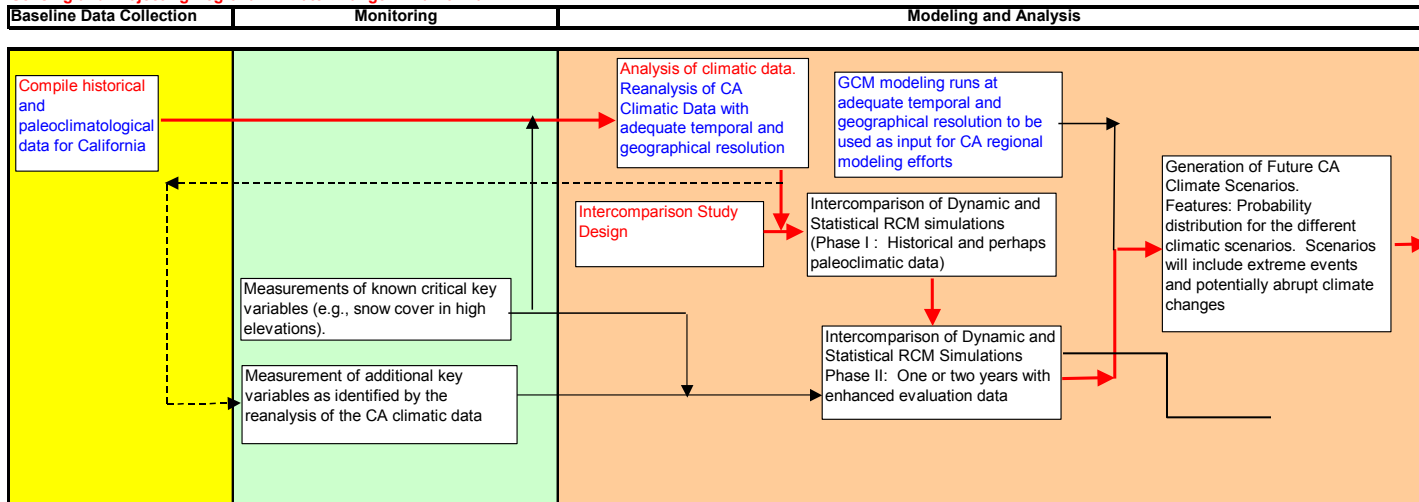


Example

- Probabilistic climate projections for California at adequate temporal and geographical resolutions for research and long-term planning



Sensing and Projecting Regional Climate Change in California



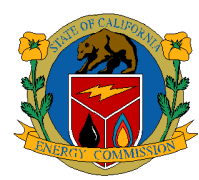
Red = Tier I (project in the critical path and when PIER may provide most of the funding, if needed)

Black = Tier II (PIER and outside funding)

Blue = Tier III (mostly outside funding)

— Critical Path

Early in 2011



2006/9/11 Assessments



Scenario Subgroup of the CAT Team

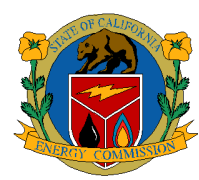
CalEPA, Natural Resources Agency, ARB, Caltrans,
DWR, OPC, Coastal Commission, BCDC, OEHHA,
Dept. of Health, Cal Fire, CDFG, CDFA, CEC

Core Group

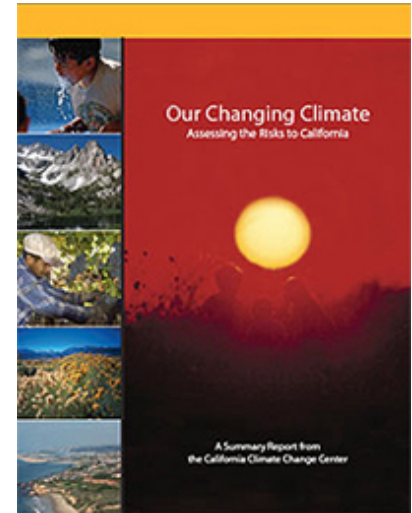
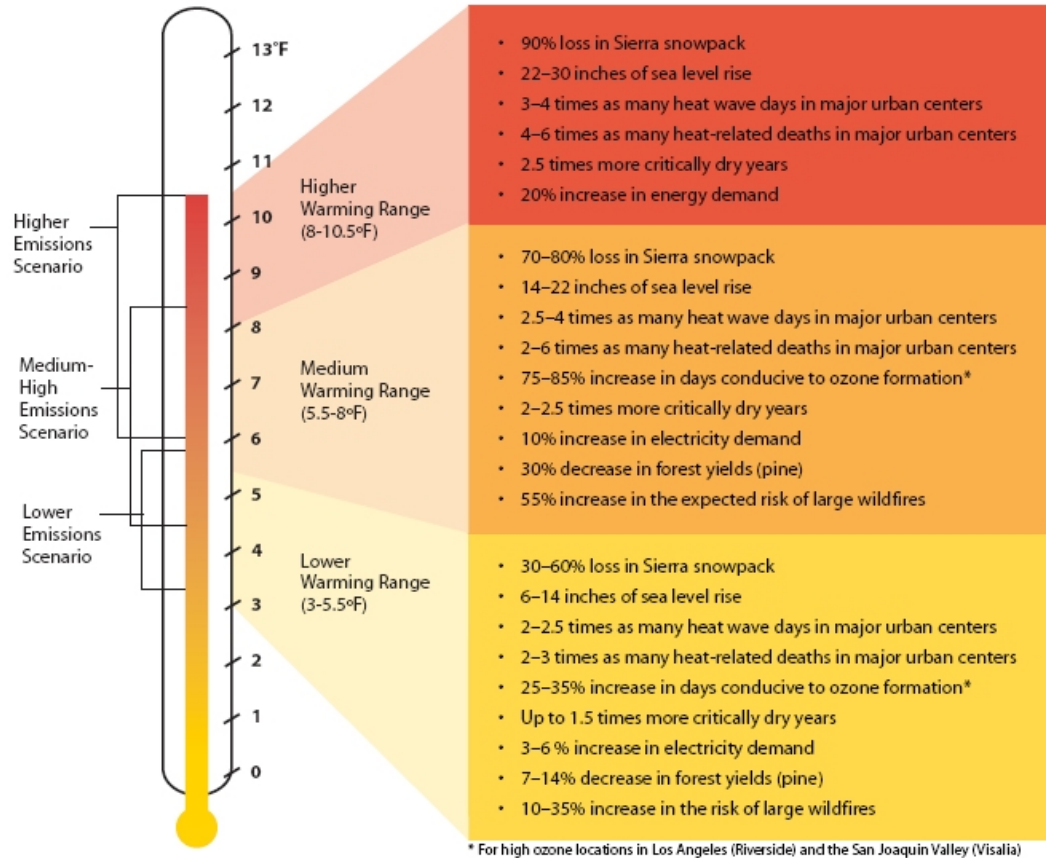
Dan Cayan (Co-Chair, Scripps), Michael Hanemann
(UC Berkeley), Andrew Altevogt (CalEPA), Alan
Sanstad (LBNL), Susanne Moser (Consultant/PIER),
Bart Croes (ARB), D. Orrill (Resources),
Guido Franco (Co-Chair – CEC)

Research Team

Scripps/UC San Diego, UC Berkeley, UC Santa Barbara, Stanford,
UC Merced, Santa Clara University, USGS, UC Davis, RAND,
Pacific Institute, JPL/UCLA, TNC, Oregon State, UC Santa Cruz,
LLNL, USFS, LBNL, OEHHA, DWR, ARB, CDF, CEC



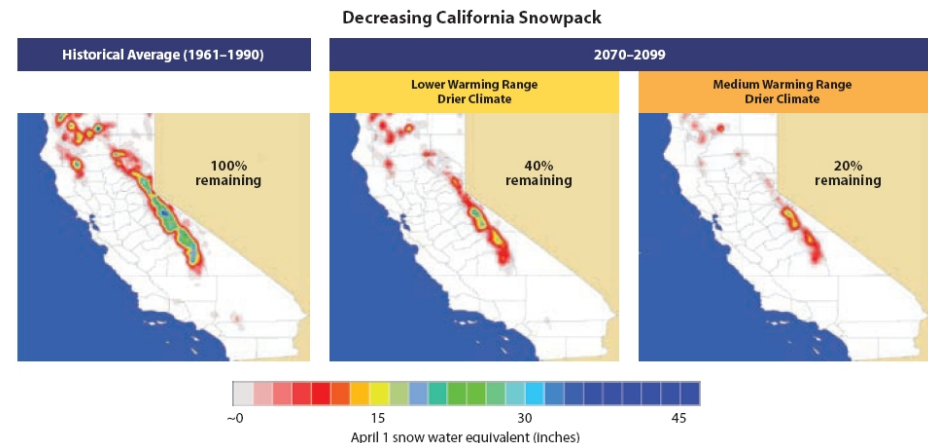
Summary of Projected Global Warming Impact, 2070–2099 (as compared with 1961–1990)

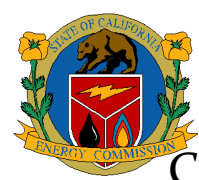


2006 Impacts Study

- Led by PIER
- About 17 scientific papers
- Special Issue in *Climatic Change*

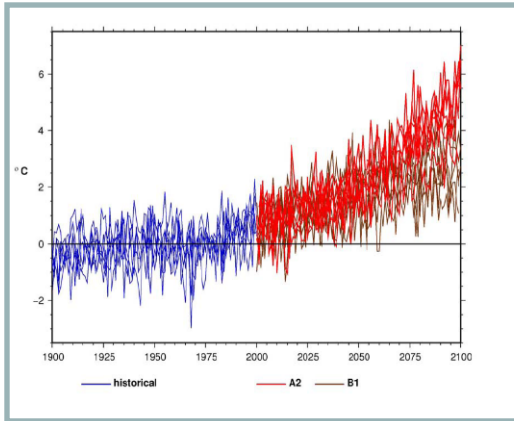
“Our Changing Climate” contributed to the passage of AB32



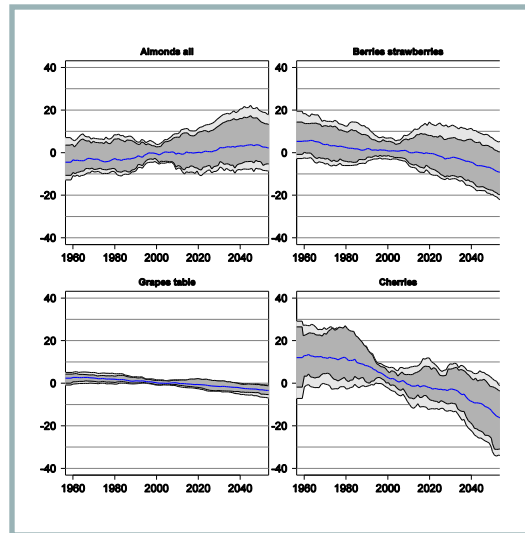


Climate and Sea Level Rise Scenarios

2009 Assessment General Approach

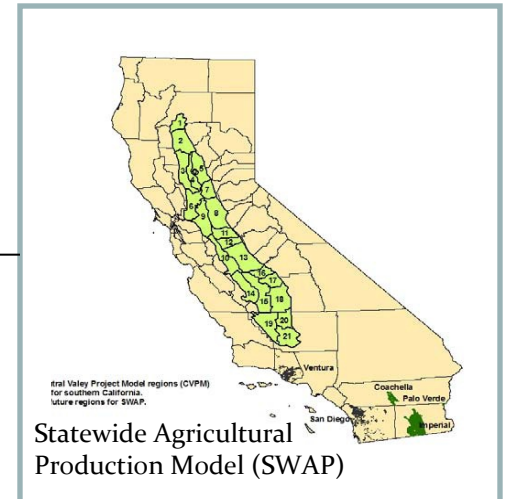


Physical Impacts



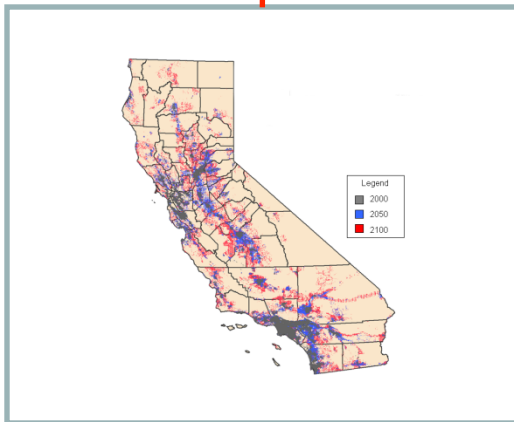
Lobell and Field (Stanford)

Economic Outcomes



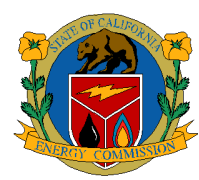
Howitt et al. (UC Davis)

Sanstad et al., (LBNL, PPIC, LLLN, CEC)



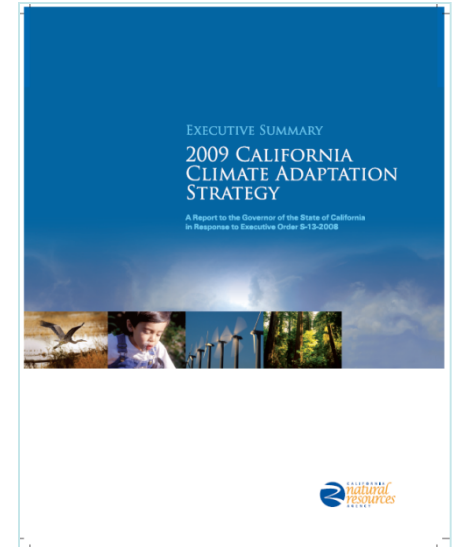
Demographic and
Urban Projections

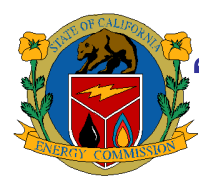
Uncertainty



2009 California Adaptation Strategy

- Unveiled by the Governor on 12/2/2009
- Requires the preparation of a Vulnerability Assessment for California [2011 Assessment]
- Creates a high level Advisory Committee that will report to the Governor late this year
- Requires updating and improving the CalAdapt website



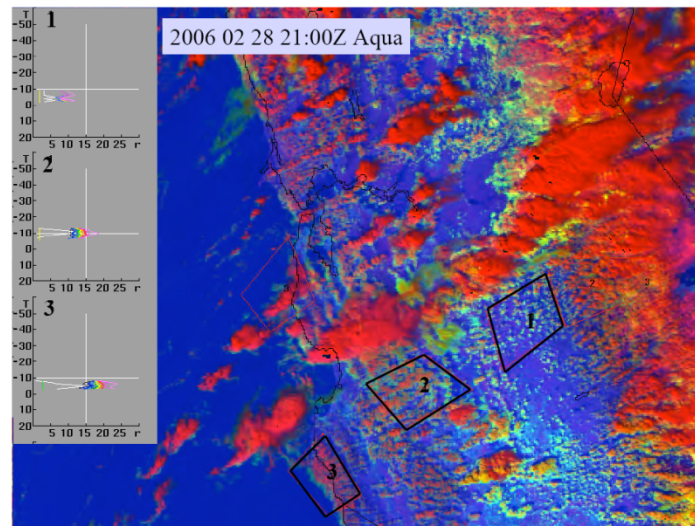
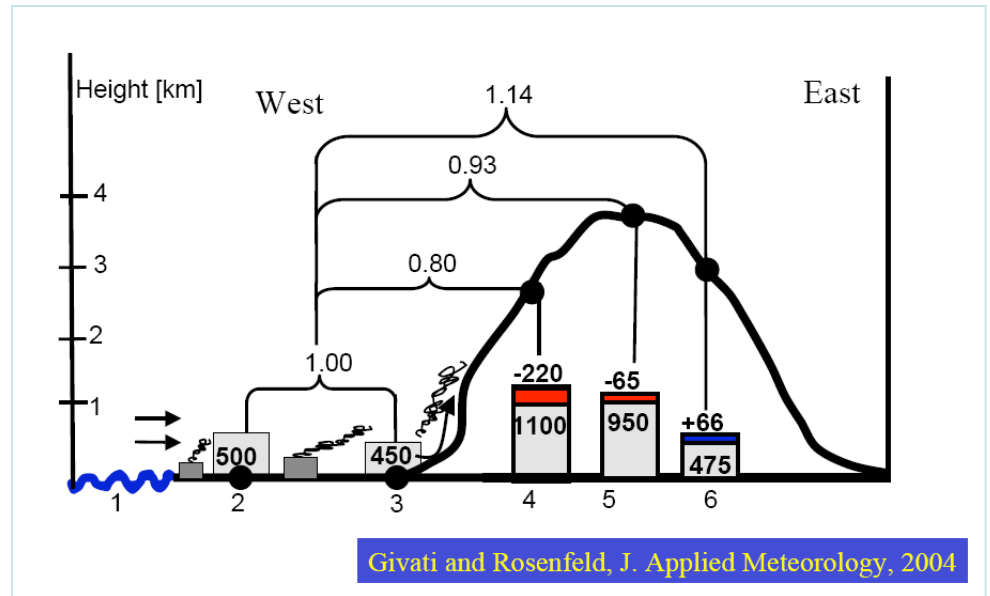


“Basic” Science Projects: Aerosols and Regional Climate

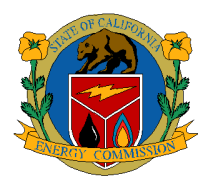
(an example of a long-term strategy)

- 2004 PIER study by Prof. Mark Jacobson (Stanford) suggested that aerosols are affecting our regional climate and precipitation levels
- Aerosols may be reducing precipitation by about 12% in the windward side of the Sierra Nevada
- Study by Prof. Rosenfeld (Hebrew University) et al. using research aircraft, satellite measurements, and numerical modeling seems to confirm this finding.
- A study by Prof. Ramanathan (Scripps) suggests that BC from Asia is affecting our climate and may be reducing snow albedo in the Sierra Nevada
- **CalWater project under way**
- Why do we need to focus on this topic?

- Properly model climate
- Potential adaptation option

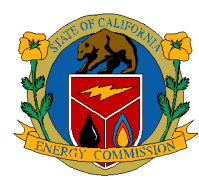


Source: Rosenfeld, D., W. L. Woodley, D. Axisa, E. Freud, J. G. Hudson, and A. Givati (2008), Aircraft measurements of the impacts of pollution aerosols on clouds and precipitation over the Sierra Nevada, J. Geophys. Res., doi:10.1029/2007JD009544



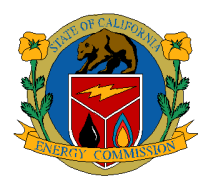
Birth of the “CalWater” experiment

- CalWater is a major effort (observations, models, diagnostics) to identify sources of uncertainty in climate projections of water supply and flood risks in California (DWR is our main state partner).
- CEC’s mission includes the development of climate scenarios for California and the estimation on how climate change may affect the energy sector including hydropower resources.
- CEC was considering a follow-on field experiment to take place in 2009 or 2010.
- A briefing on HMT was presented at the 2007 PIER Annual Climate Change Research Conference.



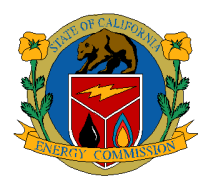
CalWater: PIER perspective

- It quickly became clear that this represented a huge opportunity for CEC to partner with NOAA and, in doing so, substantially improve the science,
 - especially by taking into account the dynamics of the atmosphere
- **Hence, the idea for “CalWater” was born.**



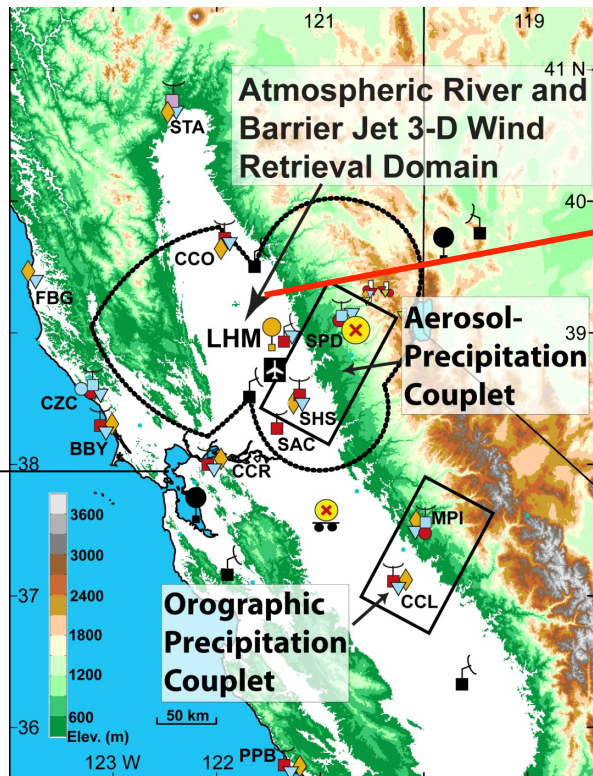
CalWater: PIER perspective

- **NOAA and its HMT Program has already proven to be an essential part of CalWater (CalWater Early Start-2009 and CalWater-2010)**
- Modern observations and physical process understanding for orographic precipitation are being combined with state-of-the-art aerosol measurements to **explore the potential role of aerosols in modifying precipitation**
- The role of atmospheric rivers (AR) in providing both critical water supply and as a key player in creating extreme precipitation and flooding has led to its selection as one of the two climate change science themes for CalWater – **is uncertainty in climate projections of precipitation due partly to errors in representing ARs?**
- A strong partnership has emerged between CEC/PIER, NOAA/HMT, USGS/Scripps, DOE/PNNL and NASA/JPL to carry out CalWater



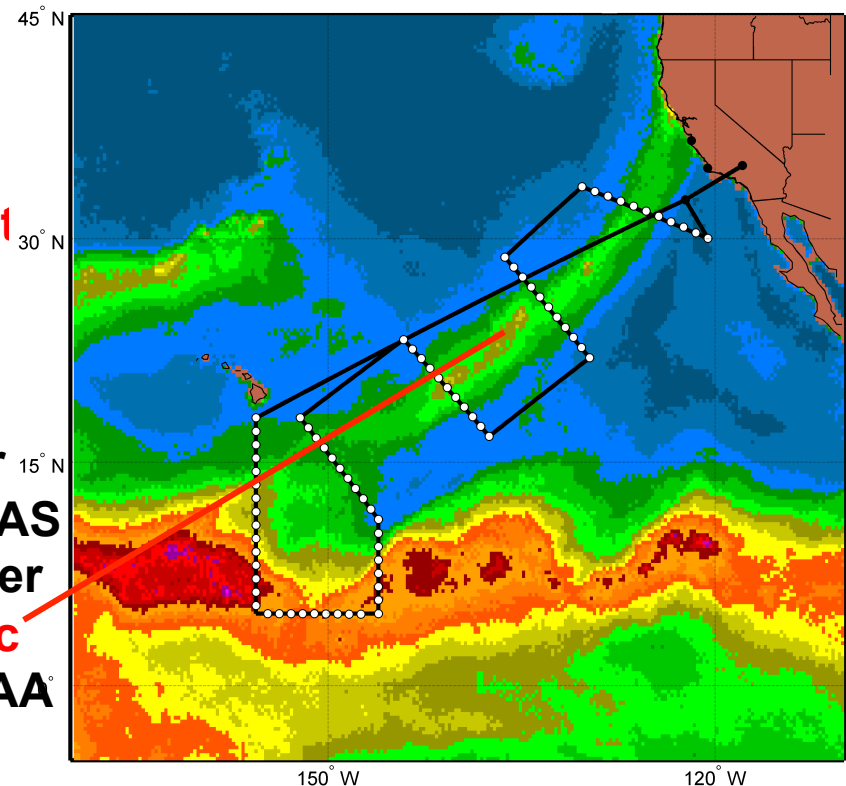
CalWater 2011

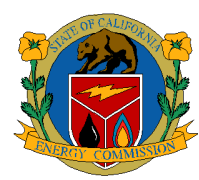
- Major experiment from 1 Dec 2010 – 15 Mar 2011:
 - NOAA SkyWater radar
 - DOE/PNNL G-1 research aircraft
 - Possible NASA Global Hawk mission with NOAA/NCAR Dropsonde



CalWater-2011
experiment,
includes the
Sierra Barrier Jet
with HMT

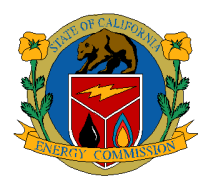
May also help
guide first-ever
Global Hawk UAS
deployment over
an **Atmospheric**
River, with NOAA
and NASA





CalWater: PIER perspective

- Results from CalWater (I, II,....) will be extremely useful in the long-run to develop more realistic climate scenarios



Thanks!